

## Two new species of myxosporidians, *Myxosoma channai* n.sp. and *Myxobolus tripathii* n.sp. from fresh water fishes of Andhra Pradesh

C KALAVATI, B V SANDEEP and C C NARASIMHAMURTI  
Department of Zoology, Andhra University, Waltair 530 003, India

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**Abstract.** Two new species of myxosporidians, *Myxosoma channai* n.sp. infecting the fins, body muscles, liver and kidney of *Channa punctata* Bl. and *Myxobolus tripathii* n.sp. infecting the gut and the liver of *Clarius* sp. are described. A checklist of all the species of myxosporidians reported from fishes of India is also given.

**Keywords.** *Myxosoma channai* ; *Myxobolus tripathii* n.sp. ; *Channa punctata* ;  
*Clarius* sp. ; new species.

### 1. Introduction

Southwell and Prashad (1918) reported the first myxosporidian from Indian fishes. Later Ray (1933), Chakravarty (1939, 1943), Ganapati (1941), Setna (1942), Chakravarty and Basu (1948), Tripathi (1952), Qadri (1962a-d, 1965, 1967, 1969 and 1970), Bhatt and Siddiqui (1964), Qadri and Lalitakumari (1965), Lalitakumari (1969), Chaudhuri and Chakravarty (1970), Choudhury and Nandi (1973), Narasimhamurti (1970), Narasimhamurti and Kalavati (1975, 1979a-c), Narasimhamurti *et al* (1980) described a number of myxosporidians belonging to different genera from fishes of India. Tripathi (1952) gave a review of the work done till 1952 and gave a checklist of all the myxosporidians reported till that time.

So far about 80 species of myxosporidia (table 2) have been described from Indian fishes. A checklist of all the species of myxosporidians described so far from India is included in the present paper because there is no such compilation after 1952 (Tripathi 1952).

While examining the fresh water fishes of Visakhapatnam District we came across 2 myxosporidians, one belonging to the genus *Myxosoma* infecting the fins, body muscles, liver and kidney of *Channa punctata* Bl. and the other belonging to the genus *Myxobolus* infecting the muscles of the gut and liver of *Clarius* sp. Both of them are considered new to science and are described in this paper.

## 2. Materials and methods

*Channa punctata* Bl. were collected from 3 different places in Visakhapatnam District; from a fresh water tank used mostly for drinking purposes located at the foot of hill in Srungavarapukota, about 30 miles north of Visakhapatnam; from an abandoned tank which has highly polluted water and plenty of green algae in Elamanchili, about 38 miles south of Visakhapatnam and a stream near the Dairy farm in Visakhapatnam. *Clarius* sp. were collected from a tank near the Visakhapatnam Port.

Different parts of the body of the fish were examined for myxosporidian parasites and when infection was detected as evident by the presence of cysts, smears were prepared, air-dried and fixed in methyl alcohol, hydrolysed in 1N HCl at 60°C for 10 min and stained with Giemsa. Smears were also wet-fixed in Schaudinn's or Carnoy's fluid and stained with Heidenhain's iron haematoxylin or according to Feulgen's technique. Fresh spores were treated with India ink and lugol's iodine to detect the presence of any mucous envelope and iodophilous vacuole. The measurements and drawings of the spores were made in the fresh condition.

## 3. Observations

*Myxosoma channai* n. sp. Host: *Channa punctata* Bl.

Site of infection: Fins, body muscles, kidney and liver.

Type slides: Author's Collection at Department of Zoology, Andhra University, Waltair (Andhra Pradesh).

68 out of 132 (51.5%) of *Channa punctata* Bl. collected from 3 different localities in Visakhapatnam District during February–April 1979 were, found infected with a new species of *myxosoma*. The size of the fish, the site and percentage of infection differed in fish collected in the different places (table 1).

32 fish brought from Srungavarapukota were maintained in aquaria tanks and fed with commercially available fish food. Infected fish from this area showed infection predominantly in the kidney and to a lesser extent in the liver. The

Table 1. Incidence of *M. Channai* in fishes collected from different localities in Visakhapatnam District.

Place	Site of infection	Size	Number examined	Number infected
Fresh water tank Srungavarapukota	Kidney and Liver	6"-7"	32	24
Fresh water tank Elamanchili	Body muscles	4"-6"	36	4
Dairy farm stream Visakhapatnam	Fins	2½"-3½"	32	20

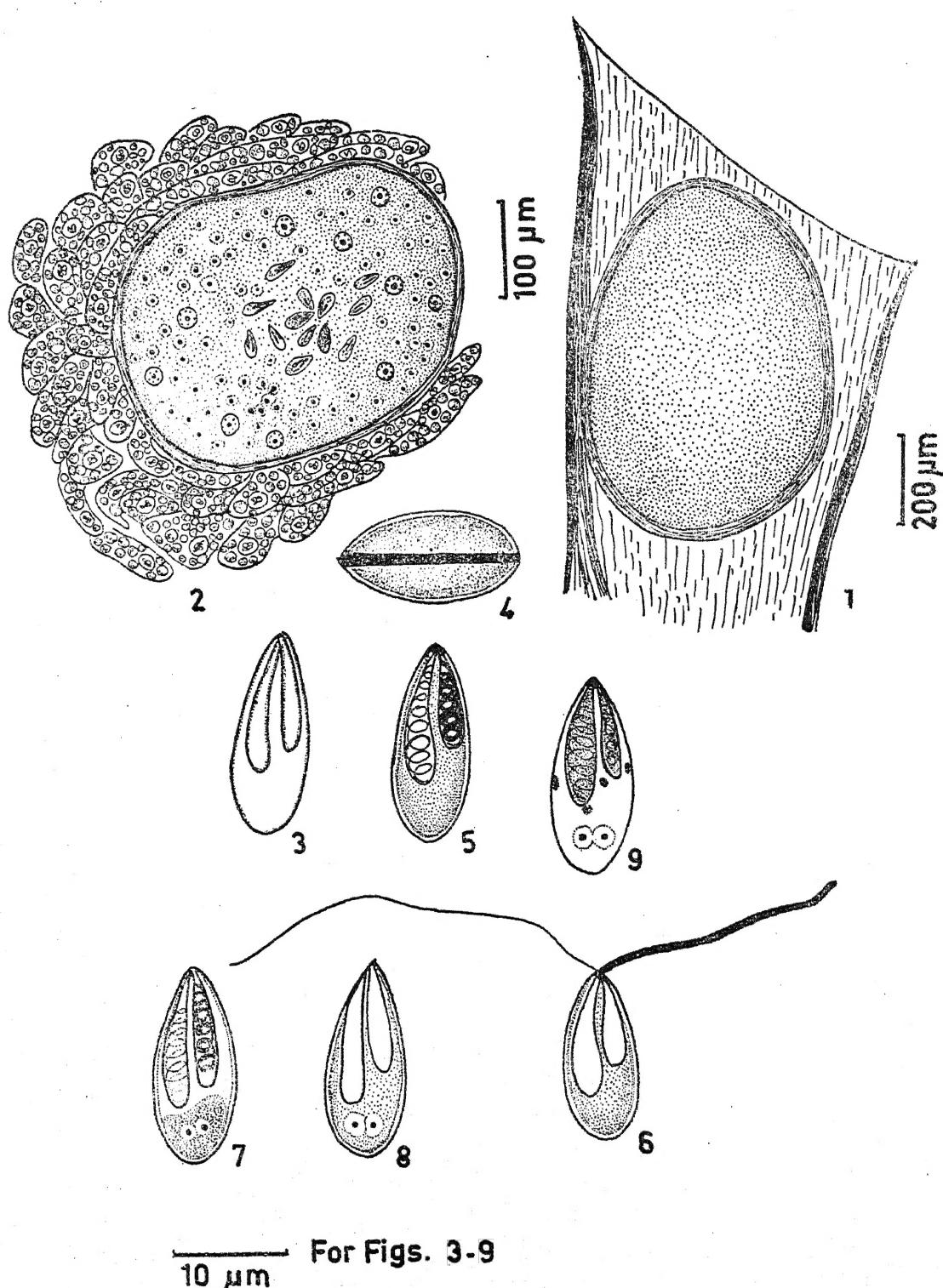
infection was heavy and each fish yielded about 10 cysts. Five out of the 7 fish which were sacrificed immediately after being brought to the laboratory showed heavy infection. More cysts were either superficially attached or deeply embedded in the kidneys and a lesser number in the liver. Unfortunately all the cysts were immature and did not show any spores. The rest of the 25 fish were maintained in the laboratory. Five of them died in 7 days and they showed infection both in the kidneys and the liver, heavier in the former than in the latter. Sections of the kidney showed cysts with few spores in the centre and developmental stages along the periphery (figure 2). The remaining 20 fish were maintained in the laboratory for another 2 weeks. The fish appeared active and there were no casualties during that period. All the fish were sacrificed at the end of 2 weeks and examined for infection and 14 of them showed heavy infection in the kidneys.

Four of the 36 fish (11%) brought from Elamanchili showed the infection limited to the body muscles. The size of the cysts varied from 0.2–0.5 mm in diameter. The infection was lighter and yielded 3 and 4 cysts in each of the 2 infected fish.

Twenty out of the 32 fish collected from the stream near the dairy farm area, Visakhapatnam showed infection limited to the fins. The infection was heavy and as many as 10 cysts were recovered from each fish. The infection was prevalent in the smaller fish and was absent in the larger fish. Cysts measuring 800–1020  $\mu\text{m}$  in diameter were either spherical or oval and were surrounded by a thin membrane (figure 1).

Sections of early cysts showed two types of nuclei, the larger nuclei which were fewer in number had a conspicuous large endosome and a distinct nuclear membrane and were probably the generative nuclei while the smaller ones which were more numerous had a small dot-like endosome and an indistinct nuclear membrane which were probably the somatic nuclei (figure 2).

*Spores:* The spores were pale brown in colour, elongately oval and had a bluntly pointed anterior end and a rounded posterior end. They measured 14.5–18  $\times$  6–6.5  $\mu\text{m}$ . The two spore valves meet along a conspicuously thick median sutural ridge (figure 4). Two polar capsules which are elongate and pear-shaped were of dissimilar size and were situated one on either side of the median line. The larger polar capsule measured 9.0–10.8  $\times$  2.8–3.2  $\mu\text{m}$  and the smaller one measured 7.2–8.8  $\times$  2.8–3.2 (figure 5). The polar filament in the larger polar capsule was thin with 8 coils wound in an anticlock wise direction and when fully everted measured 35–42  $\mu\text{m}$  in length. The polar filament from the smaller polar capsule was significantly thick, deeply stained and appeared almost solid and had 5–6 coils wound in a clock-wise direction in the polar capsule. When fully everted the polar filament measured 20–28  $\mu\text{m}$  in length. The sporoplasm was triangular in shape with rounded corners and the base was directed anteriorly (figure 7). Two deeply stained nuclei were placed a little apart along the longitudinal axis. The endosome was deeply stained but the nuclear membrane was not clear (figure 8). Some of the developing sporoblasts showed 6 nuclei, 2 lying below the capsule and 2 near the valves (between the polar capsule and the spore wall) which showed fine deeply stained chromatin granules dispersed over a wide area. A distinct nuclear membrane was not observed. The other 2 nuclei were located in the sporoplasm and have a distinct endosome and a delicate nuclear membrane.



**Figures 1-9.** *Myxosoma chennai* n.sp. 1. A cyst attached to the fin. 2. T.S. kidney showing early cyst. 3. A fresh spore. 4. Sutural view of the spore. 5. A spore stained with Giemsa. 6. Spore showing extruded polar filaments : Note polar filaments of unequal thickness and length. 7. Spores stained with iron haematoxylin. Note binucleate sporoplasm. 8. Spore stained with Feulgen. 9. A developing sporoblast.

#### 4. Discussion

16 species of myxosporidians belonging to 5 genera, *Myxobolus*, *Unicauda*, *Henneguya*, *Zschokella* and *Myxosoma* are reported from 3 species of *Channa* (= *Ophicephalus*), *C. punctata*, *C. striata* and *C. gachua* from different parts of India (table 2).

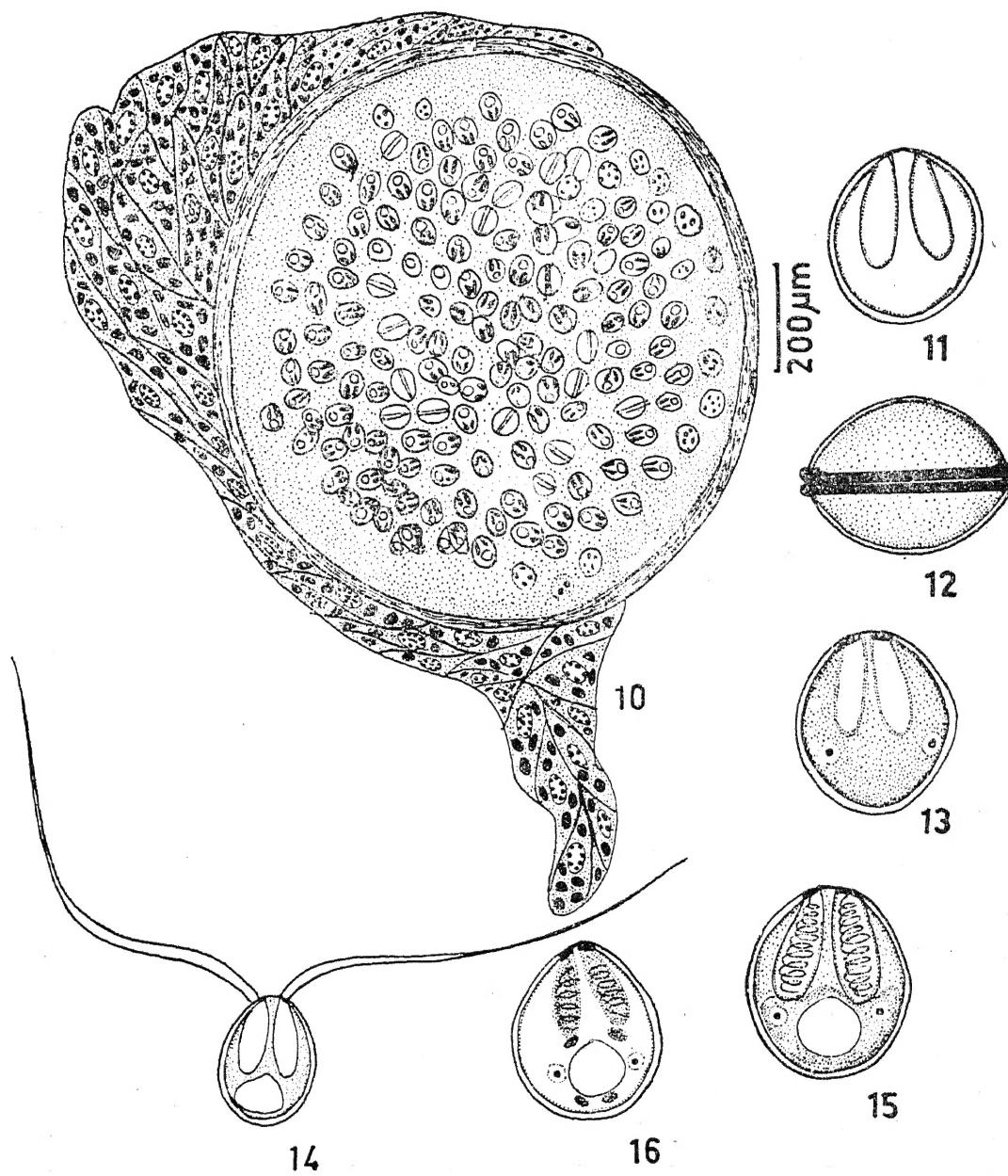
Many species of *Myxosoma* have been reported from a variety of marine and fresh water fishes from all over the world and 6 of them are from India, 3 of them from fresh water fishes of Hyderabad (Lalitakumari 1969) and 3 are from estuarine fishes of Waltair (Narasimhamurti 1970; Narasimhamurti and Kalavati 1979). Lalitakumari (1969) reported 3 species of *Myxosoma*, *M. indiae*, ( $12\cdot4-15\cdot0 \times 6\cdot4-8\cdot6 \mu\text{m}$ ), *M. hyderabadense* ( $9\cdot3-11\cdot5 \times 5\cdot0-8\cdot0 \mu\text{m}$ ) and *M. andhrae* ( $12\cdot1-15\cdot7 \times 5\cdot7-8\cdot6 \mu\text{m}$ ). Narasimhamurti (1970) and Narasimhamurti and Kalavati (1979) reported 3 more species, *M. intestinalis* ( $12\cdot5-13\cdot5 \times 8\cdot6-9\cdot5 \mu\text{m}$ ), *M. lairdi* ( $9\cdot0-9\cdot5 \times 4\cdot6-5\cdot3 \mu\text{m}$ ) and *M. microspora* ( $4\cdot8-5\cdot2 \mu\text{m}$  in diameter). Among them the spores of *M. hyderabadense*, *M. lairdi* and *M. microspora* are much smaller than the present form ( $14\cdot5-18\cdot0 \times 6\cdot0-6\cdot5 \mu\text{m}$ ) though the polar capsules were of a similar size. The spores of *M. indiae*, *M. andhrae* and *M. intestinalis* are bigger in size but are still smaller than the present form. The present form resembles *M. indiae* and *M. andhrae* in having unequal sized polar capsules. In *M. indiae* the unequal polar capsules were stated to be 2 or 3 in number and are smaller than those in the present form. The sporoplasm in *M. indiae* extends a little into the intercapsular space and hence differs from the present form. The spores of *M. andhrae* (which has the same host as the present form) though large are smaller than the present form and posses parietal folds which are absent in the present form. The present form resembles *M. andhrae* in having unequal-sized polar capsules but differs from it because the sporoplasm extends into the intercapsular space upto the anterior pole while in the present case it is triangular and is located at the posterior pole. Some of the spores in *M. andhrae* show an appendage measuring  $1\cdot0-3\cdot6 \mu\text{m}$  which is absent in the present form. The polar filaments in *M. andhrae* appear to be similar (as seen from figure 20) while they appear and measure differently in the present form. The cysts in *M. andhrae* were attached to the gut by means of small fibres while in the present case the cysts are attached to fins or tissues directly or embedded in the tissue. Thus the only species of *Myxosoma*, *M. andhrae* which is reported from the same host as the present form differs considerably, hence this is considered a new species and the name *Myxosoma channai* n. sp. after the host is proposed for the same.

*Myxobolus tripathii* n. sp. Host : *Clarius* sp.

Site of infection : Wall of gut and visceral organs.

Type slides : Author's collection and Department of Zoology, Andhra University, Waltair (Andhra Pradesh).

3 out of 75 *Clarius* sp. ranging in size from 7.5-8.0 inches and collected from a tank near Visakhapatnam Port were found infected with a new species of *Myxobolus*. Opaque white cysts ranging in diameter from 0.5-1.0 mm were either superficially attached to the gut epithelium or deeply embedded in the liver tissue. The cyst wall was thin and single. Cellular hypertrophy associated with vacuo-



**Figures 10-16.** *Myxobolus tripathii* n.sp. 10. T.S. liver showing an attached cyst. 11. A fresh spore. 12. Sutural view of the spore. 13. A spore treated according to Feulgen's technique. 14. Spore showing extruded polar filaments. 15. Spore stained with Giemsa : Note coiled polar filament. 16. A developing sporoblast.

lation of the cytoplasm was observed in the adjacent tissue cells. In some of the cells the nucleus also showed hypertrophy but there was no rupture of the cell (figure 10).

Fresh spores were either rounded or oval measuring  $9.8-10.2 \times 12.0-13.5 \mu\text{m}$  (figure 11). The spore walls were symmetrical and meet along the thickened sutural ridge which was further thickened at the poles (figure 12). 2 oval polar capsules of equal size measuring  $5.0-6.0 \times 2.5 \mu\text{m}$  were present, one on either side of the median line and they open independently to the outside. A prominent cushion-like thickening which was strongly basophilic was present at the openings (figure 13). The polar filaments showed 8 coils in each of the polar capsules and they were coiled in an anticlock wise direction. The polar filaments were uniformly thin and when fully everted measured  $45-50 \mu\text{m}$  in length (figure 14). An oval iodinophilous vacuole measuring  $3.6-4.5 \mu\text{m}$  which was stained with Lugol's iodine, positive to PAS and Best's carmine and negative to PAS after saliva digestion was present at the posterior pole (Figures 15 and 16). Similar tests conducted on the spores of the new species of *Myxosoma* reported earlier in this paper were negative. The sporoplasm was binucleate and extended like a rim round the iodine vacuole. 2 widely separated vesicular nuclei were present in the sporoplasm (figure 15). In immature spores 2 capsulogenous nuclei at the base of the polar capsules and 2 valvulogenous nuclei at the posterior end below the iodine vacuole were usually present in addition to the 2 sporoplastic nuclei situated on either side of the iodinophilous vacuole (figure 16).

#### 4. Discussion

The present form is placed in the genus *Myxobolus* because of the presence of an iodinophilous vacuole in the spore (Kudo 1920). Walliker (1968) synonymised the genus *Myxosoma* and *Myxobolus* because of the variability of occurrence of iodine vacuole. Lom (1969) endorsed the view of Walliker, thus abolishing the family Myxosomatidae. However, Galinsky and Meglitsch (1969) felt that the vacuole is useful and a well established taxonomic character. Podlipaivi (1974) stated that the iodine vacuole is "a real morphological formation in the spores of Myxobolidae and should be used in systematics". Moser and Noble (1977), Wold and Iverson (1978) expressed a similar opinion in the matter. Since a distinct iodine vacuole is present in the present form and accepting the opinion expressed by the above authors that the iodine vacuole has taxonomic importance, we propose to assign the parasite described here to the genus *Myxobolus* Buetschli 1882.

To date as many as 133 species of *Myxobolus* have been reported from a variety of marine and fresh water fishes from different parts of the world. Among them 19 species are described from the fresh water fishes of India. A perusal of table 2 shows that the only previous record of *Myxobolus* from *Clarius* is *M. clarii* (Chakravarty 1943) from the gall bladder, liver, testes, ovary and fat bodies. The cysts of the present form are bigger in size when compared to the cysts of *M. clarii*. The spores in *M. clarii* measured  $11.3-12.4 \times 10.3 \mu\text{m}$ , were subspherical in shape with a distinct straight sutural ridge whereas in the form described here the spores are spherical or ovoidal and have a thick sutural ridge which is further

Table 2. Checklist of myxosporidian parasites reported from the fresh water fishes of India.

Parasite	Host	Site of infection	Spore measurements (microns)
	Ord. : Unipolarina Fam : Ceratomyxidae		
Genus : <i>Ceratomyxa</i> Thelohan 1892			
1. <i>C. hilsae</i> Chakravarty 1939	<i>Hilsa ilisha</i>	Gall bladder	25-40
2. <i>C. gobiodesi</i> Chakravarty 1939	<i>Odontamblyopus rubicunda</i> ; <i>Colisa fascianus</i>	Gall bladder	14-15
3. <i>C. scatophagi</i> Chakravarty 1943	<i>Scatophagus argus</i>	Gall bladder	16-26 (breadth)
4. <i>C. sagarica</i> Choudhury and and Nandi 1973	<i>Boleophthalmus boddarti</i>	Bile	31 (breadth)
	Genus : <i>Leptotheca</i> Thelohan 1895		
5. <i>L. latosi</i> Chakravarty 1943	<i>Lates calcarifer</i>	Gall bladder	10.3-12.4 (diameter)
6. <i>L. macronesi</i> Chakravarty 1943	<i>Macronemus Giulio</i>	Gall bladder	10-14.4
7. <i>L. asymmetrica</i> Lalitakumari 1969	<i>Osteochilus neilli</i>	Gills, Gall bladder and intestine	9.4 (breadth)
	Genus <i>Sphaerospora</i> Thelohan 1892		
8. <i>S. sp.</i> *Southwell and Prashad 1918	<i>Barilius barna</i>	Under scales	No details
	Genus : <i>Gyrospora</i> Qadri 1962		
9. <i>G. crucifila</i> Qadri 1962	<i>Labeo fimbriatus</i>	Gills	9-10 x 8-8.5
	Fam : <i>Chloromyxidae</i> Thelohan 1892		
	Genus : <i>Chloromyxum</i> Mingazzini 1890		

10.	<i>C. amphipnoui</i> Ray 1933	<i>Amphipnous cruchi</i> <i>Heteropneustes fossilis</i> <i>Amblypharyngodon mola</i>	Gall bladder	8·24 × 10·3
11.	<i>C. mirigale</i> Tripathi 1952	<i>Cirthina mirigala</i> , <i>C. reba</i>	Gall bladder	9-10 (diameter)
12.	<i>C. sp.</i> Tripathi 1952	<i>Xenentodon canicula</i>	Gall bladder	7·2 (diameter)
13.	<i>C. hoarei</i> Lalitakumari 1969	<i>Labeo nigripinnis</i>	Gall bladder	5·7-7·1 × 2·5-3·5
		Genus : <i>Kudoa</i> Meglitsch 1947		
14.	<i>K. chilakensis</i> Tripathi 1952	<i>Strongylura strongylura</i>	Muscles and peri-tonaeum in oeso-phageal region	5·5-5·8 × 7·2
15.	<i>K. tetraspora</i> Narasimhamurti and Kalavati 1979	<i>Mugil cephalus</i>	Optic lobes	9 (diameter)
16.	<i>K. sphyræni</i> Narasimhamurti and Kalavati 1979	<i>Sphyraena jello</i>	Gut	9·4 × 9·8
		Fam : Myxosomatidae		
		Genus : <i>Myxostoma</i> Thelohan 1892		
17.	<i>M. indicae</i> Lalitakumari 1969	<i>Barbus sarana</i>	Gill filaments	12·4-15 × 6·4-8·6
18.	<i>M. hyderabdense</i> Lalitakumari 1969	<i>Barbus pinnarautius</i>	Gills	9·3-11·5 × 5-8
19.	<i>M. andhrae</i> Lalitakumari 1969	<i>Ophicephalus punctatus</i>	Outer wall of intestine	12·1-15·7 × 5·7-8·6
20.	<i>M. intestinalis</i> Narasimhamurti and Kalavati 1970	<i>Mugil waigensis</i>	Gut epithelium	12·5-13·5 × 8·6-9·5
21.	<i>M. lairdi</i> Narasimhamurti and Kalavati 1979	<i>Liza macrolepis</i>	Gut epithelium	4·6-5·2 × 9-9·5
22.	<i>M. microspora</i> Narasimhamurti and Kalavati 1979	<i>Mugil cephalus</i>	Gills	4·8-5·2 (diameter)
23.	<i>M. channai</i> n. sp. (present record)	<i>Channa punctata</i>	Fins, body muscles, liver and kidney	14·5-18 × 6-6·5

\* From Kudo (1920).

Table 2. (Contd.)

	1	2	3	4
Family :	Myxobolidae			
Genus :	<i>Myxobolus</i> Buetschli 1882			
24.	<i>M. mirigale</i> Chakravarty 1939	<i>Cirrhina mirigala</i> <i>Labeo catbasu</i> , <i>L. rohita</i> ,	Scales Gall bladder	7·21-8·24 × 6·18 12·4-15 × 8·2-10
25.	<i>M. calbausi</i> Chakravarty 1939	<i>Cirrhina mirigala</i>	Gall bladder	11·3-12·4 × 10·3
26.	<i>M. clarii</i> Chakravarty 1943	<i>Clarias bairachus</i>	Liver, Testes fat bodies	14·5-16·5 × 6·18
27.	<i>M. catlae</i> Chakravarty 1943	<i>Catla catla</i> , <i>Labeo rohita</i> , <i>Cirrhina mirigala</i> <i>Catla catla</i>	Branchiae	8·56-9·36 × 6·42-6·80
28.	<i>M. bengalensis</i> Chakravarty and Basu 1948	<i>Cirrhina mirigala</i>	Scales Gill filaments	7·21-8·24 × 6·18 6·4-7 × 4·5-5 × 3·2-4
29.	<i>M. indicum</i> Tripathi 1952	<i>Barbus sarana</i>	Skin	12·6-13·5 × 9 × 5·5-6·3
30.	<i>M. branchialis</i> Tripathi 1952	<i>Barbus ticto</i>	Scales	9·9-5 × 7·2 × 5·5-5
31.	<i>M. barbi</i> Tripathi 1952	<i>Cirrhina mirigala</i>	Accessory respiratory membrane	11·6-13·3 × 4·6-6·3
32.	<i>M. sphericum</i> Tripathi 1952	<i>Ophicephalus punctatus</i>	Accessory respiratory membrane	11·4-15 × 6-7·2
33.	<i>M. ophicephali</i> Bhatt and Siddiqui 1964	<i>Ophicephalus punctatus</i>	Accessory respiratory membrane	9·7 × 7
34.	<i>M. dilgarhensis</i> Bhatt and Siddiqui 1964	<i>Barbus pinnarautius</i>	Gill filaments	9·3-10·7 × 8·6-10
35.	<i>M. pinnarautii</i> Lalitakumari 1969	<i>Psilorhynchus balitora</i>	Dorsal and ventral fins	8·6-10·7 × 6·4-7·9
36.	<i>M. psilorhynchi</i> Lalitakumari 1969	<i>Barbus pinnarautius</i>	Liver and intestine	12·15 × 7·1-10
37.	<i>M. ampullaceus</i> Lalitakumari 1969	<i>Barbus kolus</i>	Gill contents	6·3-7·9 × 4·3-6·4
38.	<i>M. osmaniae</i> Lalitakumari 1969	<i>Barbus punaubensis</i>		
39.	<i>M. potaili</i> Lalitakumari 1969	<i>Labeo potail</i>		

40.	<i>M. punctatus</i> Chaudhuri and Chakravarty 1970	<i>Ophicephalus punctatus</i>	Spleen (in all)
41.	<i>M. tripathii</i> (present record)	<i>Clarias</i> sp.	Pharyngeal epithelium (in one) Liver, intestine, muscles
Genus <i>Unicauda</i> Davis 1944			
*42.	<i>U. ophicephali</i> Tripathi 1952	<i>Ophicephalus punctatus</i> ; <i>O. gachua</i>	Gills
*43.	<i>U. basirii</i> Bhatt and Siddiqui 1964	<i>Ophicephalus punctatus</i>	Mouth cavity Pharyngeal epithelium
*44.	<i>U. bicornuta</i> Chaudhuri and Chakravarty 1970	<i>Ophicephalus punctatus</i>	Branchial epithelium
*45.	<i>U. bengalensis</i> Chaudhuri and Chakravarty 1970	<i>Ophicephalus punctatus</i>	Roof of Buccal cavity
Genus : <i>Henneguya</i> Theodoan 1892			
46.	<i>H. latei</i> Chakravarty 1939	<i>Lates calcarifer</i>	Gills
47.	<i>H. ophicephali</i> Chakravarty 1939	<i>Ophicephalus punctatus</i>	Branchiae and muscles
48.	<i>H. otolithi</i> Ganapati 1941	<i>Otolithus ruber</i> , <i>O. maculatus</i>	Wall of Bulbous arteriosus
49.	<i>H. zahoori</i> Bhatt and Siddiqui 1964	<i>Ophicephalus punctatus</i>	Tissues of gill filaments
50.	<i>H. notopteriae</i> Qadri 1965	<i>Notopterus notopterus</i>	Gills
51.	<i>H. qadrii</i> Lalitakumari 1965	<i>Ophicephalus gachua</i>	Viscera
52.	<i>H. singhi</i> Lalitakumari 1969	<i>Notopterus osmaniae</i>	Gill contents (appendage)
53.	<i>H. jubili</i> Qadri 1969	<i>Notopterus notopterus</i>	No measurements
54.	<i>H. waltairensis</i> Narasimhamurty and Kalavati 1975	<i>Ophicephalus punctatus</i>	14·6-16·5 × 3·2-4 (Excl. caudal appendage)
54.	<i>H. ganapatiiae</i> Qadri 1970	<i>Notopterus notopterus</i>	Gills

Table 2. (Contd.)

	1	2	3	4
Genus : <i>Thelohanellus</i> Kudo 1933				
55.	<i>T. rohitae</i> Southwell and Prashad 1918	<i>Labeo rohita</i>	Gills	30-32 × 7-8
56.	<i>T. semi</i> Southwell and Prashad 1918	<i>Catla catla Labeo rohita</i>	Branchiae	13.2-13.6 × 10.1-10.3
57.	<i>T. carlcae</i> Chakravarty and Basu 1948	<i>Catla catla</i>	Gills	19.26-21.40 × 10.7-12.4
58.	<i>T. calbasui</i> Tripathi 1952	<i>Labeo calbasu</i>	Scales	9-10.8 × 7.2-5.5
59.	<i>T. gangeticus</i> Tripathi 1952	<i>Labeo rohita, Chela bacaila</i>	Pectoral region	16.2-17.5 × 5.4-3.5
60.	<i>T. mrigala</i> Tripathi 1952	<i>Cirrhina mrigala</i>	Cysts on head between eyes	10.8-12 × 6.3-7.2 × 4.5-5.4
61.	<i>T. andhrae</i> Qadri 1962	<i>Labeo fimbriatus</i>	Gills	11.25-14.5 × 4.5-5.5
62.	<i>T. borgotii</i> Qadri 1962	<i>Labeo borgot</i>	Gills	11-12 × 6-7.5
63.	<i>T. batiae</i> Lalitakumari 1969	<i>Labeo batia</i>	Gills	11.4-13.6 × 4.3-7.9
64.	<i>T. chelae</i> Lalitakumari 1969	<i>Chela becaila</i>	Bile	9.4-10.3 × 4.6-6
65.	<i>L. potaili</i> Lalitakumari 1969	<i>Labeo potail</i>	Gill contents	12.1-16 × 7.9-9.5
66.	<i>T. shortii</i> Qadri 1969	<i>Labeo fimbriatus</i>	Fins	11.42-12.85 (12.53) × 6.42-7.14 (6.91)
Genus : <i>Phlogospora</i> Qadri 1962				
67.	<i>P. mystii</i> Qadri 1962	<i>Mystus bleekeri</i>	Gill contents	14-18 × 3.5-5
Genus : <i>Myxobolus</i> Davis 1944				
68.	<i>M. mastacembelii</i> Qadri and Lalitakumari 1965	<i>Mastacembelus armatus</i>	Gills, intestine	23.5-30.5 × 4.6-6.16

69.	<i>N. tetraradiata</i> Tripathi 1952	<i>Odontamblyopus rubicundus</i>	Gills	79.20-93.6 × 5.4
		Order : Bipolarina		
		Family : Myxidiidae		
		Genus : <i>Myxidium</i> Butschli 1882		
70.	<i>M. lieberkunii</i> Butschli 1881	<i>Anabas testudineus</i> , <i>Boleophthalmus boddaerti</i>	Gall bladder	14.1 × 3.6
71.	<i>M. glossogobii</i> Chakravarty 1939	<i>Glossogobius giuris</i>	Gall bladder	12.15 × 8.5-10
72.	<i>M. heteropneustii</i> Chakravarty 1943	<i>Heteropneustes fossilis</i>	Gall bladder	14.42 × 6.18
73.	<i>M. procerum</i> var. calcarifory Chakravarty 1943	<i>Lates calcarifer</i>	Gall bladder	23-27 × 6.18
74.	<i>M. aori</i> Lalitakumari 1969	<i>Macrones aor</i>	Gall bladder	11.4-13.6 × 5.4-7.1
75.	<i>M. boddaerti</i> Choudhury and Nandi 1973	<i>Boleophthalmus boddaerti</i>	Gut	15.48 × 7.7
		Genus : <i>Zschokkella</i> Auersbach 1970		
76.	<i>Z. ilisha</i> Chakravarty 1943	<i>Hilsa ilisha</i>	Gall bladder	12.36 × 6.18
77.	<i>Z. fossiliae</i> Chakravarty 1943	<i>Heteropneustes fossilis</i>	Gall bladder	10.3 × 4.12 × 5.18
78.	<i>Z. ophicephali</i> Lalitakumari 1969	<i>Ophicephalus striatus</i>	Gall bladder	12.9-14.3 × 5-7.1
79.	<i>Z. labonis</i> Lalitakumari 1969	<i>Labeo nigripinnis</i>	Gall bladder	9.3-12.9 × 4.3-7.1
		Genus : <i>Sphaerospora</i> Thelohan 1892		
80.	<i>S. puttai</i> Tripathi 1952	<i>Odontamblyopus rubicundus</i>	Gall bladder	28.8-30 × 5-5.5
81.	<i>S. theraponi</i> Tripathi 1952	<i>Therapon jarbua</i>	Gall bladder	19.8 × 5.4

Table 3. Myxosporidia reported from *Channa (Ophicephalus)*.

Parasite	Host	Site of infection	Description of the (spore Measurements in microns)
1. <i>Myxosoma andhrae</i> Lalitakumari 1969	<i>Ophicephalus punctatus</i>	Outer wall of intestine	Spores pyriform ellipsoidal, in some, the posterior end is drawn into an appendage 1.4-3.6 in length. Spores 12.1-15.7 × 5.7-8.6. Polar capsules unequal. Polar filament length not given.
2. <i>M. channai</i> n. sp. (present record)	<i>Channa punctata</i> (= <i>Ophicephalus punctatus</i> )	Kidney, Liver, body muscles and fins	Spores pyriform or oval 14.5-18.0 × 6.0-6.5. Thick median sutural ridge. Polar capsules dissimilar. Large polar filament 35.0-42.0, small 20.0-28.0. No iodophilous vacuole.
3. <i>Myxobolus ophicephali</i> Bhatt and Siddiqui 1964	<i>Ophicephalus punctata</i>	Accessory respiratory organs	Spores pyriform. 11.6-13.3 × 4.6-6.3. Polar capsules unequal. Large 6.9-8.5 × 1.2-2; Small 6.7-7.3 × 1.2-2.
4. <i>M. aligarhensis</i> Bhatt and Siddiqui 1964	<i>Channa punctata</i> (= <i>Ophicephalus punctatus</i> )	Accessory respiratory organs	Spores pyriform, shell valves smooth and symmetrical 11.4-15 × 6-7.92. Polar capsule equal 7.6-9.2 × 1.2-2.2 polar filament not mentioned.
5. <i>M. punctatus</i> Chaudhuri and Chakravarty 1970	<i>Channa punctata</i> (= <i>Ophicephalus punctatus</i> )	Spleen and pharyngeal epithelium	Spores pyriform 12.29-15 × 5.72-7.86. Polar capsules equal 8.57-10 × 2.14-2.86. Polar filament 42.25-32.56.

\*6. *Unicauda ophicephali* Tripathi 1952      *Ophicephalus punctatus* and *O. gachua*      Gills      Spores pyriform  $19\cdot8\text{--}26\cdot4 \times 5\cdot4\text{--}7\cdot2$ . Caudal prolongation  $20\cdot5\text{--}23\cdot8$  polar capsules unequal large :  $7\cdot2\text{--}8\cdot1 \times 2\text{--}3$  small :  $5\cdot5\text{--}7\cdot2 \times 2\text{--}3$ . Polar filament not recorded.

\*7. *U. basirii* Tripathi 1952      *Ophicephalus punctatus*      Mouth cavity Pharyngeal epithelium      Spores oval the posterior end of shell. Valve prolonged into a more or less extended process to form a single caudal appendage. Spore  $25\cdot6\text{--}39\cdot2 \times 3\cdot2\text{--}4\cdot4$ . Caudal appendage  $10\text{--}20\cdot3$ .

\*8. *U. bicornuta* Chaudhuri and Chakravarty 1970      *Ophicephalus punctatus*      Branchial epithelium and Gills      Spore oblongate. Posterior portion gradually tapering and continued into long caudal prolongation. Characteristically forked at the posterior end.  $35\cdot73\text{--}45\cdot3 \times 2\cdot86\text{--}4\cdot29$ . Caudal prolongation  $14\cdot29\text{--}27\cdot15$ .

\*9. *Unicauda bengalensis* Chaudhuri and Chakravarty 1970      Roof of buccal cavity      Spores oblongate, spore body continued into a long caudal prolongation which is single and undivided. Spore  $26\cdot4\text{--}29\cdot15 \times 2\cdot75\text{--}3\cdot85$ . Caudal prolongation  $11\cdot55\text{--}13\cdot75$ . Polar capsules equal,  $3\cdot33\text{--}3\cdot56 \times 1\cdot1\text{--}1\cdot38$ . Polar filament  $18\text{--}27$ .

10. *Henneguya ophicephali* Chakravarty 1939      *Ophicephalus punctatus* Branchiae and muscles      Spore ovoid or oblongate tail bifurcated  $41\cdot5\text{--}52\cdot5 \times 6\cdot18\text{--}7\cdot21$ . Caudal prolongation  $20\text{--}32$ . Polar capsule  $6\cdot18\text{--}9\cdot27 \times 2\cdot06\text{--}3$ . Polar filament  $26\text{--}32$ .

11. *H. qadrii* Lalitakumari 1965      *O. gachua*      Viscera near spleen      Spores oval, caudal appendage bifurcated spore  $15\cdot4\text{--}26\cdot9 \times 4\cdot62\text{--}5\cdot39$ . Caudal appendage  $6\cdot16\text{--}14\cdot63$ . Polar capsules unequal. Large :  $4\cdot62\text{--}6\cdot16 \times 1\cdot15\text{--}1\cdot92$  small :  $3\cdot85\text{--}4\cdot62 \times 1\cdot15\text{--}1\cdot92$ . Polar filament large  $41\cdot85\text{--}53\cdot13$ , small  $28\text{--}46\cdot2$ .

Table 3. (Contd.)

1	2	3	4	5
12. <i>H. zahoori</i> Bhatt and Siddiqui 1964 <i>O. punctatus</i>	Tissue of gill filaments	Spore biconvex $20-30.6 \times 2.1-3$ caudal appendage bifurcated $12-18.6$ . Polar capsules equal $4.9-6.7 \times 0.7-1.1$ .		
13. <i>H. jubili</i> Qadri 1969 <i>Notopterus notopterus</i>		Only a short description. No measurements given.		
14. <i>H. granapataiae</i> Qadri 1970 <i>Notopterus notopterus</i>	Gill contents	Length of the spore $9.28-9.99$ (9.72). Breadth of the spore $4.0-4.28$ (4.50) Length of the caudal appendage $21-25$ (22-25), Length of polar capsule $3.21-3.57$ (3.32). Breadth of polar capsule $1.42-1.78$ (1.64).		
15. <i>H. waltairensis</i> Narasimhamurti 1975 <i>Ophiccephalus punctatus</i>	Gill filaments	Spore $14.6-16.5 \times 3.2-4$ Caudal prolongation $40-50$ . Polar capsules spherical $10-12 \times 1.6-2.5$ .		
16. <i>Zschokkella ophiccephali</i> Lalitakumari 1969 <i>O. striatus</i>	Gall bladder	Spores gibbous shaped in front view $12.9-14.3 \times 5.7-1$ . Polar capsule spherical with prominent neck. $3.6-3.9$ . Polar filament $61-78$ sporoplasma trapezoid.		

\* Wyatt (1979) while discussing the characters of the genus *Unicuda* stated that " *Unicuda* was established by Davis for organisms with unbranched tails which are not extensions of the spore valves. In general the anterior end of the tail has a concavity and the spore sits in this cup". Hence he says *U. basirii* Bhatt and Siddiqui is an example of misuse of the definition of Davis—and all the 4 species described above do not fit into the genus. He, however, did not suggest a new place for the above species in any one of the described genera.

thickened at the poles. The 2 polar capsules in *M. clarii* are pear-shaped measuring  $6.18 \times 3.09 \mu\text{m}$  with the anterior end drawn out into a narrow tube and open to the outside at the same point (figures 60 and 65 of Chakravarty 1943). The sporoplasm occupies the entire extra capsular region and the 2 nuclei are closely associated (Figs. 63 and 64 of Chakravarty 1943) while in the present form the 2 oval polar capsules are smaller measuring  $5.0-6.0 \times 2.0-2.5 \mu\text{m}$  and open to the outside independently, one on either side of the median line and the openings are covered by a cushion-like thickening. Further the sporoplasmic nuclei are always present one on either side of the vacuole.

In view of the differences mentioned above, we consider the present form as a new species for which the name *Myxobolus tripathii* n. sp. is proposed.

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#### References

Bhatt V S and Siddiqui W A 1964 Four new species of Myxosporidia from the Indian fresh water fish, *Ophicephalus punctatus* Bloch; *J. Protozool.* **11** 314-316

Chakravarty M M 1939 Studies on Myxosporidia from fishes of Bengal with a note on the myxosporidian infection in aquaria fishes; *Arch. Protistenk.* **92** 169-178

Chakravarty M M 1943 Studies on Myxosporidia from the common food fishes of Bengal; *Proc. Indian Acad. Sci.* **B18** 21-35

Chakravarty M M and Basu S P 1948 Observations on some Myxosporidians parasitic in fishes with an account of nuclear cycles in one of them; *Proc. Zool. Soc. Bengal* **1** 23-33

Chaudhuri S R and Chakravarty M M 1970 Studies on Myxosporidia (Protozoa : Sporozoa) from the food fishes of Bengal. Three new species from *Ophicephalus punctatus* Bl.; *Acta Protozool.* **8** 160-173

Choudhury A and Nandi N C 1973 Studies on Myxosporidian parasites (Protozoa) from an estuarine gobiid fish of West Bengal; *Proc. Zool. Soc. Calcutta* **26** 45-55

Ganapati P N 1941 On a new myxosporidian, *Henneguya otolithi* n.sp. A tissue parasite from the Bulbus arteriosus of two species of fish of the genus *Otolithus*; *Proc. Indian Acad. Sci. B13* 135-150

Galinsky D and Meglitsch P A 1969 Notes on the effects of pretreatment of spores on the iodino-phile vacuole of *Henneguya exilis*; *Proc. Iowa Acad. Sci.* **76** 431-435

Kudo R R 1920 Studies on Myxosporidia; *Ill. Bio. Mono.* **5** 265

Lalitakumari P S 1969 Studies on parasitic protozoa (Myxosporidia) of fresh water fishes of Andhra Pradesh, India; *Riv. Parasitol.* **30** 154-225

Lom J 1969 On a new taxonomic character in Myxosporidia, as demonstrated in descriptions of two new species of *Myxobolus*; *Folia Parasitol. (Praha)* **16** 97-103

Moser M and Noble E R 1977 Three genera of Myxosporidia (Protozoa) in macrourid fishes; *Int. J. Parasitol.* **7** 93-96

Narasimhamurti C C 1970 *Myxosoma intestinalis* n.sp. (Protozoa : Myxosporidia) from the gut epithelium of the estuarine fish, *Mugil waicensis* (Quoy and Gaimard); *Proc. Indian Acad. Sci. B71* 19-27

Narasimhamurti C C and Kalavati C 1975 A new myxosporidian parasite *Henneguya waltairensis* n.sp. from the gills of *Ophicephalus punctatus*; *Riv. Parasitol.* **36** 255-273

Narasimhamurti C C and Kalavati C 1979a *Kudoa sphyraeni* n.sp. (Protozoa : Myxosporidia) parasitic in the muscles of the gut of the marine fish *Sphyraena Jello* Cuv.; *Proc. Indian Acad. Sci. B88* 265-269

Narasimhamurti C C and Kalavati C 1979b *Myxosoma lairdi* n.sp. (Protozoa : Myxosporidia) parasitic in the gut epithelium of the estuarine fish, *Liza macrolepis* Smith; *Proc. Indian Acad. Sci. B88* 269-273

Narasimhamurti C C and Kalavati C 1979c *Kudoa tetraspora* (Protozoa : Myxosporidia) parasitic in the brain tissue of *Mugil cephalus*; *Proc. Indian Acad. Sci. B* **88** 85-89

Narasimhamurti C C, Kalavati C and Saratchandra B 1980 A new myxosporidian *Myxosoma microspora* n.sp. from *Mugil cephalus*; *J. Fish. Biol.* **16** 345-348

\*Podlipaivi S A 1974 Polysaccharides in spores of myxosporidians of the family Myxobolidae; *Parazit (Leningrad)* **8** 535-542

Qadri S S 1962a New myxosporidia from Indian fresh water fish, *Labeo fimbriatus* I. *Gyrospora crucifila* gen. n. sp.n.; *Z. Parasitkde.* **21** 513-516

Qadri S S 1962b New myxosporidia from the Indian fresh water fish, *Labeo fimbriatus* II. *Thelohanellus andhrae* sp.n.; *Z. Parasitkde* **21** 517-520

Qadri S S 1962c On a new myxosporidian parasite, *Phlogospora mysti* gen. n. sp.n. from Indian fresh water fish *Mystus bleekeri*; *Arch. Protistenk.* **106** 211-217

Qadri S S 1962d On a new myxosporidian *Thelohanellus boggoti* n.sp. from an Indian fresh water fish, *Labeo boggut*; *Arch. Protistenk.* **106** 218-222

Qadri S S 1965 Study on a new myxosporidian parasite from a fresh water fish, *Notopterus notopterus*; *Zool. Anz.* **175** 225-228

Qadri S S 1967 On a new myxosporidian *Thelohanellus shortii* n.sp. from a fresh water fish, *Labeo fimbriatus*, A.P. India; *Protozoology* **11** 207-213

Qadri S S 1969 On a new myxosporidian *Henneguya jubili* n.sp. from fresh water fish, *Notopterus notopterus* of Andhra Pradesh, India. Progress on Protozool, 3rd Inter. Congr. Protozoology, Leningrad

Qadri S S 1970 On a new parasite *Henneguya ganapatiae* n.sp. from fresh water fish of Hyderabad, Prof. Ganapati. Shash Comm. Vol. 1-5.

Qadri S S and Lalitakumari P S 1965 A new myxosporidian *Myxobilatus mastacembeli* from fresh water fish, *Mastacembelus armatus*; *Riv. Parasitol.* **26** 73-78

Ray H N 1933 Preliminary observations on Myxosporidians from India; *Curr. Sci.* **1** 349-350

Setna S B 1942 Preliminary observations on myxosporidia from sharks; *Curr. Sci.* **11** 469-470

Southwell T and Prasad B 1918 Notes from Bengal Fishery Laboratory, No. 5, Parasites of Indian fishes, with a note on carcinoma in the climbing perch; *Rec. Indian Mus.* **15** 341-355

Tripathi Y R 1952 Studies on parasites of Indian fishes. 1. Protozoa : Myxosporidia together with a check list of parasitic protozoa described from Indian fishes; *Rec. Indian Mus.* **50** 63-88

Walliker D 1968 The nature of the iodinophilous vacuole of myxosporidian spores, and a proposal to synonymise the genus *Myxosoma* Thelohan, 1892 with the genus *Myxobolus* Buetschli, 1882; *J. Portozool.* **15** 571-575

Wold Diana and Iversen E S 1978 *Myxobolus latipinnacola* new species (Myxosporidia) from the sail fin Molly, *Poecilia latipinna* (Lesueur) in Southern Florida; *Bull. Mar. Sci.* **28** 377-380

Wyatt E J 1979 *Facieplatycauda pratti* gen. n. sp.n. and two new species of *Myxobolus*; *J. Portozool.* **26** 47-50